PROC. ENTOMOL. SOC. WASH.
88(1), 1986, pp. 98–109

NEOTROPICAL TINEIDAE, II: BIOLOGICAL NOTES AND DESCRIPTIONS OF TWO NEW MOTHS PHORETIC ON SPINY POCKET MICE IN COSTA RICA (LEPIDOPTERA: TINEOIDEA)

DONALD R. DAVIS, DALE H. CLAYTON, DANIEL H. JANZEN, AND ANNE P. BROOKE

(DRD) Department of Entomology, National Museum of Natural History, Smithsonian Institution, Washington, D.C. 20560; (DHC) Committee on Evolutionary Biology, University of Chicago, Chicago, Illinois 60637; (DHJ) Department of Biology, University of Pennsylvania, Philadelphia, Pennsylvania 19104; (APB) Museum of Vertebrate Zoology, University of California, Berkeley, California 94720.

Abstract.—Two new species of tineid moths discovered riding on the backs of two species of spiny pocket mice (Heteromyidae) in Costa Rica are described. *Amydria selvae,* new species, was found on *Heteromys desmarestianus* Gray in the rainforest at Finca La Selva and *Ptilopsaltis santarosae,* new species, occurred on *Liomys salvini* (Thomas) in the dry forest at Santa Rosa National Park. Only female moths were observed and collected. Biological observations on both moths and their hosts in phoresy are summarized.

Recent live-trapping of spiny pocket mice in Costa Rican forests has revealed the association of three species of phoretic moths of the family Tineidae. The life histories of the moths are still poorly understood and only the females are known to be phoretic. No males of any of the three species have been discovered. Excavations of the burrows of the two species of spiny mice are now underway, which we hope will reveal not only the presence of males with associated immatures but also the larval biology.

All moths (females) were collected from the backs of two species of mice from two quite different localities. In the drier, deciduous forest habitat of Santa Rosa National Park, a new species of *Ptilopsaltis* was found on *Liomys salvini* (Thomas). At the wetter, evergreen forest habitat of La Selva, two species of Tineidae were collected from the backs of *Heteromys desmarestianus* Gray. One of these, *Amydria selvae,* new species, is described herein. The other, apparently another undescribed *Ptilopsaltis* quite distinct from the one at Santa Rosa, has not been named due to inadequate material.

Comparison of these "mouse moths" with the well known sloth moths (Waage and Montgomery, 1976) is inevitable, although much of the life history of the former is still conjecture. Of the 16 species now recognized in the exclusively American genus *Amydria,* food preferences of only two have been noted. Johnson and Martin (1969) report larvae of *A. effrentella* Clemens feeding on dried plant

(nest) material in mountain beaver burrows. Populations of *A. arizonella* Dietz have been commonly observed by the senior author in numerous bat caves throughout southwestern United States, where the larvae burrow and feed in bat guano (Davis, 1972). From these two accounts, it is likely that *A. selvae* will prove to be a scavenger within the nests of *H. desmarestianus,* either on mouse dung or on plant debris, with the latter most probable.

Even though the neotropical genus *Ptilopsaltis* is reportedly monotypic (type = *P. synchorista* Meyrick, Fig. 4) and known only from Trinidad (Davis, 1984), the senior author knows of at least five other species ranging from the southwestern United States to Venezuela, in addition to the two mentioned in the present paper. Little has been published previously on the food habits of *Ptilopsaltis,* although specimen labels on *P. synchorista* Meyrick in the BMNH state "larva feeding on seeds disgorged by Guacharo bird on floor of limestone cave" in Trinidad. This suggests that *P. santarosae,* new species, may also feed on plant debris in the nests of *Liomys salvini.*

The pretarsi of both species of mouse moths were examined by the senior author in search of special adaptations for clinging to the hairs of their hosts. The results were somewhat inconclusive and will be discussed further in a future revision of the genus *Ptilopsaltis.* All pretarsi of female *Amydria selvae* are similar with little modification except for the disorientation of one tarsal claw on the fore- and midlegs (Fig. 11). The pretarsi of female *Ptilopsaltis santarosae* are much more modified with one tarsal claw disoriented and one pulvillus reduced on the fore- and midlegs (Fig. 13). The hind-pretarsi are even more specialized with elongate but symmetrical claws and greatly reduced arolium (Figs. 15, 16). Examinations of other *Ptilopsaltis* species show similar pretarsal specializations in both males and females.

Deposition of specimens referred to in this paper are as follows: BMNH, for British Museum (Natural History), London, England; MNCR, Museo Nacional de Costa Rica, San Jose, Costa Rica; UCB, University of California, Berkeley, California; and USNM, National Museum of Natural History (formerly United States National Museum), Smithsonian Institution, Washington, D.C.

Amydria selvae Davis, New Species

Figs. 1, 5, 7, 11–12

Adult (Fig. 1).—Length of forewing: ♀, 5–6 mm. A relatively small species with pale buff to cream colored body and forewings, possessing a few brownish fuscous spots around margin of wing. Male unknown.

Head: Vestiture rough on vertex, relatively smooth on frons, uniformly cream colored except for lateral patches of fuscous on frons near margin of eye. Antennae approximately 0.6 the length of forewing, 54–59 segmented; scape mostly pale buff to cream with anterior margin fuscous; pecten absent; flagellum uniformly cream; smooth. Maxillary palpi greatly reduced, 1 minute segment. Labial palpi mostly pale buff to cream with latero-ventral surfaces of I and basal half of II fuscous; II also with 3–4 dark bristles laterally.

Thorax: Pronotum pale buff to cream. Tegulae with fuscous on anterior margin. Venter cream to white. Forewings pale buff to cream, nearly immaculate except for 2–3 small costal spots, 4–5 extremely small subterminal spots and one mod-

Figs. 1–4. Adult moths. 1, *Amydria selvae,* ♀ holotype, forewing length 6 mm. 2, *A. pauculella,* ♀ holotype, forewing length 8 mm. 3, *Ptilopsaltis santarosae,* ♀ holotype, forewing length 10 mm. 4, *P. synchorista,* ♂ holotype, forewing length 7 mm.

erately large subtornal spot; all markings dark brownish fuscous; fringes pale buff to cream. Hindwings uniformly whitish cream, slightly whiter than forewings. Forelegs pale buff to cream ventrally, brownish fuscous dorsally with apices of tibiae and tarsal segment, and entire pretarsus suffused with pale buff; arolium and pulvilli well developed on all legs. Midlegs mostly cream ventrally, brownish fuscous dorsally with apices of tarsal segments and entire pretarsus suffused with pale buff. Hindlegs predominantly cream to white, dorsal surfaces of outer four tarsal segments gray with pale buff suffusion at apices.

Abdomen: Uniformly pale buff.

Female genitalia: As shown in Fig. 7. Ovipositor extremely short, moderately broad. Posterior apophyses short; anterior apophyses absent. Ostium relatively simple, flush with body wall. Caudal half of ductus bursae slightly enlarged and thickened to form a distinct antrum; ductus then narrowing to a slender, short tube to corpus bursae. Corpus bursae with a relatively slender lobe arising from caudal end near junction with ductus bursae. Signum absent.

Immature stages.—Unknown.

Holotype.—♀. Finca La Selva Biological Station, near Puerto Viejo de Sarapiquí, Heredia Province, Costa Rica; 13 July 1984, coll. A. P. Brooke, ex ♂ *Heteromys*, trap no. 4 (UCB).

Paratypes.—Same locality as holotype: 1 ♀, 5 July 1984, D. H. Clayton; 1 ♀, 8 July 1984, D. H. Clayton; 2 ♀, 20 July 1984, ♀ 41 E4, A. P. Brooke; 1 ♀, 23 July 1984, E 1 on no. 0003, A. P. Brooke. Paratypes deposited in MNCR, UCB, USNM.

Host.—Larval substrate unknown; adult females collected riding on live *Heteromys desmarestianus* Gray.

Flight period.—July.

Distribution.—Known only from the type locality, which is a lowland evergreen rainforest site (ca. 100 m) located one km upstream from Puerto Viejo de Sarapiquí, Finca La Selva Biological Station, Heredia Province, Costa Rica.

Etymology.—The specific epithet is derived from the general type locality (La Selva) of the species.

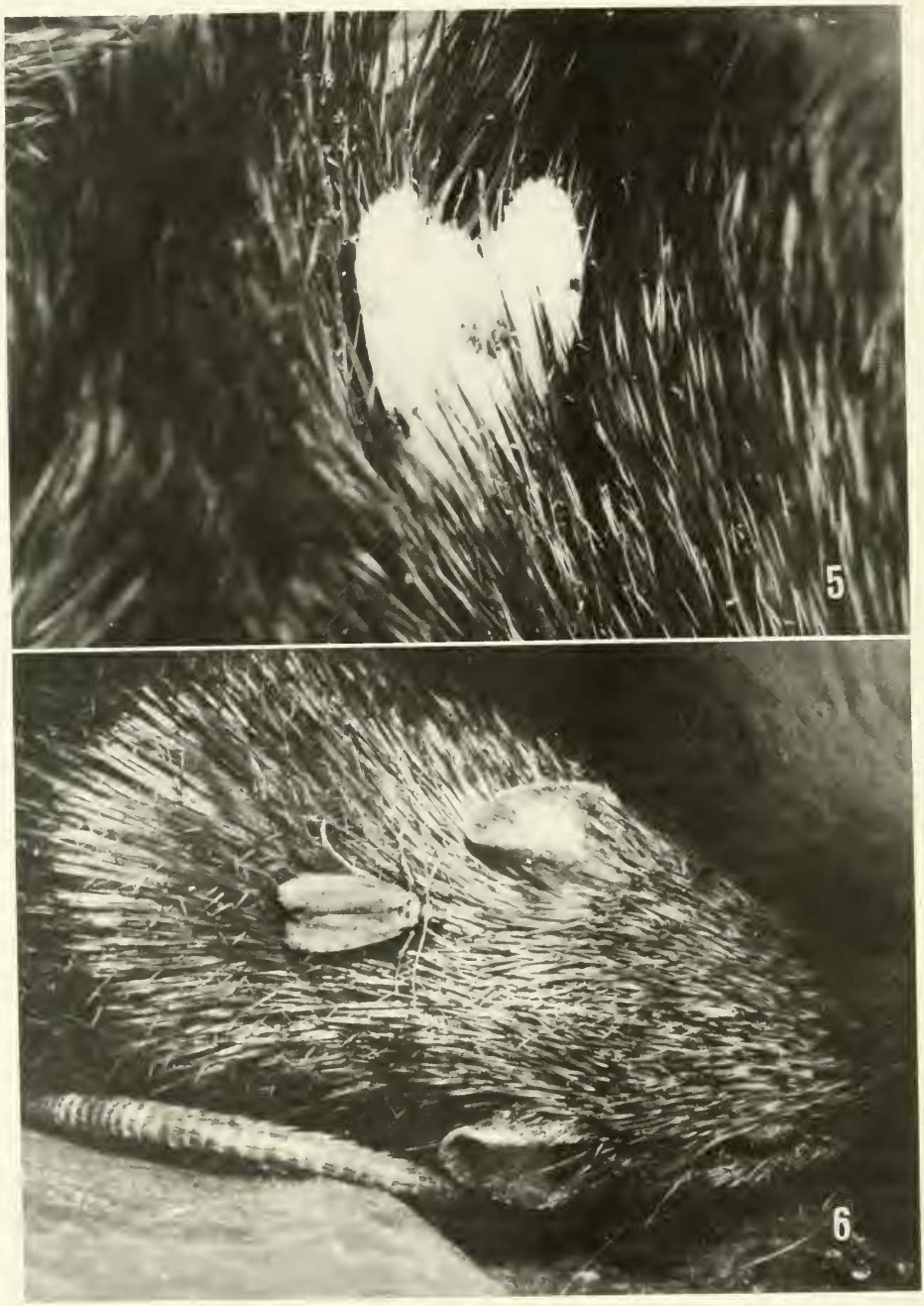
Discussion.—*Amydria selvae* most closely resembles *A. pauculella* (Walker) known only by the female type from Venezuela. Both species possess pale buff forewings with a few dark spots bordering the wing margins. The forewings of female *A. pauculella* (Fig. 2) are slightly larger, measuring 8 mm in length compared to 5 to 6 mm for *A. selvae*. The most diagnostic features distinguishing the females of the two species are the relative development of the sterigma (see Figs. 7–8), ductus bursae, and accessory bursae. Walsingham (1914) mistakenly records *A. pauculella* from Costa Rica. His material, from Volcan de Irazu, actually represents an undescribed species of *Amydria*.

Biological observations.—*Amydria selvae* were collected from *Heteromys desmarestianus* Gray captured in Tomahawk live-traps at Finca La Selva (10°30′N, 84°00′W), a lowland (ca. 100 m) wet forest site one km upstream from Puerto Viejo de Sarapiquí, Prov. Heredia, Costa Rica. Traps were baited with corn and set in a grid covering several hectares of an overgrown cacao (*Theobroma cacao*) plantation. *H. desmarestianus* is a locally abundant heteromyid rodent inhabiting montane or tropical rain forests of Mexico, Costa Rica, and Panama. It is primarily granivorous and collects seeds in external cheek pouches, later storing them in underground burrow systems. Adult males average 83 g and females 62 g (Fleming, 1974).

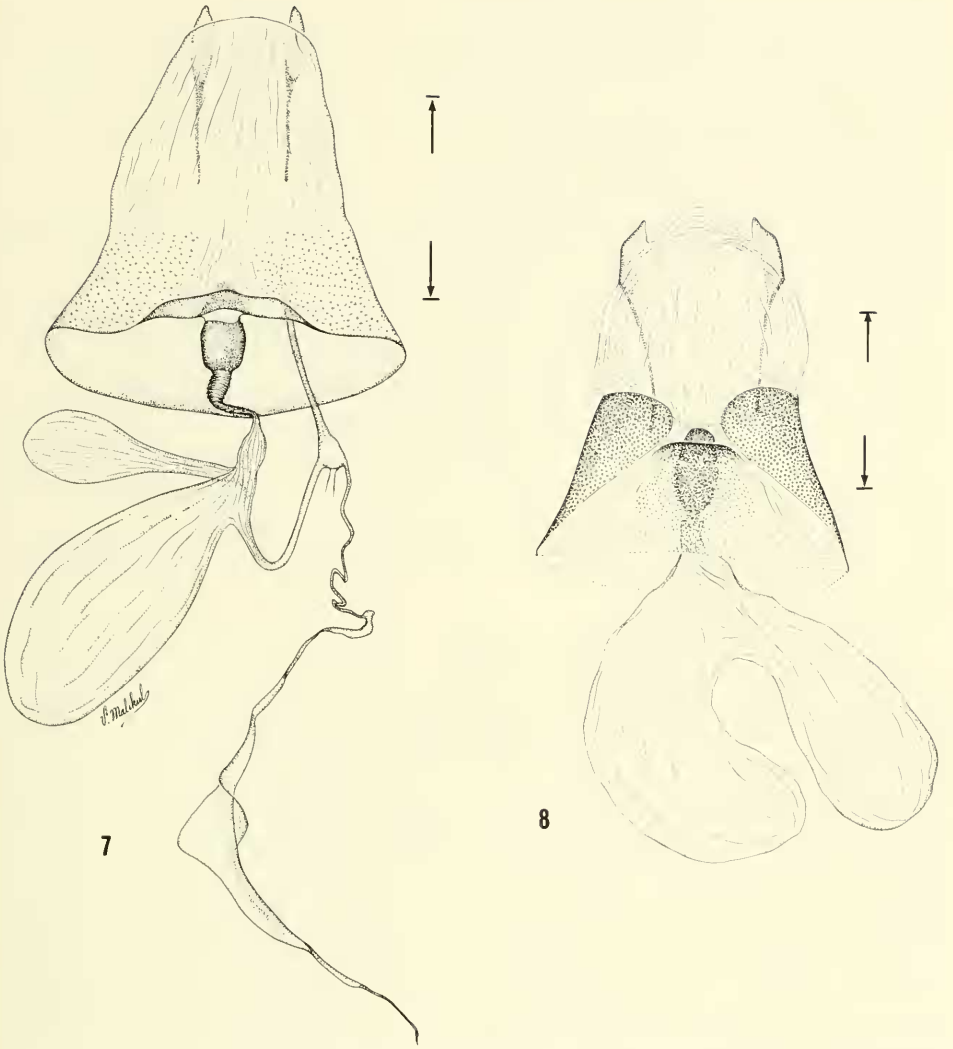
A total of 58 *H. desmarestianus* (female : male = 2:5) was trapped nocturnally throughout July, 1984 and examined for moths the following morning. Ten female moths were collected from six *H. desmarestianus* (two adult males, three adult females, and one female, age unknown). Five additional moths were observed on mice, but flew before capture. Male mice carried four moths apiece; three females carried two apiece and a fourth female (adult) carried one moth. One adult female first captured with no moths was recaptured several days later carrying two moths. Another adult female from which two moths were removed at first capture was recaptured eight days later with no moths.

Moths were not collected from any of 50 additional *H. desmarestianus* trapped in other lowland and highland areas of Costa Rica during July–August, 1984. Furthermore, during an intensive trapping campaign of three weeks at Finca La Selva in late August and September, no moths were observed on any of 160 individually marked *H. desmarestianus*.

Most moths were observed on the rumps of mice, either on the surface of the



Figs. 5, 6. Live female mouse moths in situ on backs of hosts. 5, *Amydria selvae* embedded in the fur of *Heteromys desmarestianus*. 6, *Ptilopsaltis santarosae* riding motionless on the back of *Liomys salvini*.



Figs. 7, 8. Female genitalia, ventral view. 7, *Amydria selvae*. 8, *A. pauculella*. (Scales = 0.5 mm.)

pelage or embedded in it with only the tips of the wings and abdomen exposed (Fig. 5). One moth was collected from the shoulder of a mouse and another was collected from the tail of another mouse. Except for the tail, these regions are well protected from host grooming, a major source of mortality for arthropod associates of vertebrates (Marshall, 1981). Bell and Clifford (1964) demonstrated the importance of allogrooming (grooming of one individual by another) between the sexes for the control of ectoparasites on mice. It would be interesting to know whether there is any impact of grooming and allogrooming on mouse moths. The wings of some moths were tattered, perhaps due to host grooming or abrasion against the spiny pelage of *H. desmarestianus*.

Mouse moths are capable of enduring considerable activity on the part of the

host. In one case, a moth remained on its mouse for well over an hour as the mouse, an escapee, was chased wildly about the laboratory. When placed in a petri dish in the lab, moths were capable of rapid locomotion, preferring the curved sides of the dish to its flat, but more exposed, top or bottom. Assisted by the presence of arolia on the hindlegs, moths were able to walk vertically and upside down on plastic and glass surfaces.

Waage (1979) distinguished two general types of association between Lepidoptera and vertebrates: "those involving prolonged adult association with the host and larval dependence on the host's microhabitat, and those involving only brief adult feeding associations and no larval dependence."

We have not observed reproduction in *Amydria selvae.* However, closely related species are known to fit Waage's first category of asociation. Johnson and Martin (1969) collected more than 300 *A. effrentella* from each of several nests of mountain beavers (*Aplodontia rufa*). Both adults and larvae were found in the nests, where the larvae fed on decaying vegetation. Davis (1972) reported the larvae of *A. arizonella* burrowing in the accumulated bat guano of caves. Jellison (1940) noted that species of several tineid genera were common inhabitants of the nests of various mammals and birds. He considered *Amydria* sp. to be a regular associate in the nests of burrowing owls (*Speotyto cunicularia*) and pocket gophers (*Geomys floridanus*).

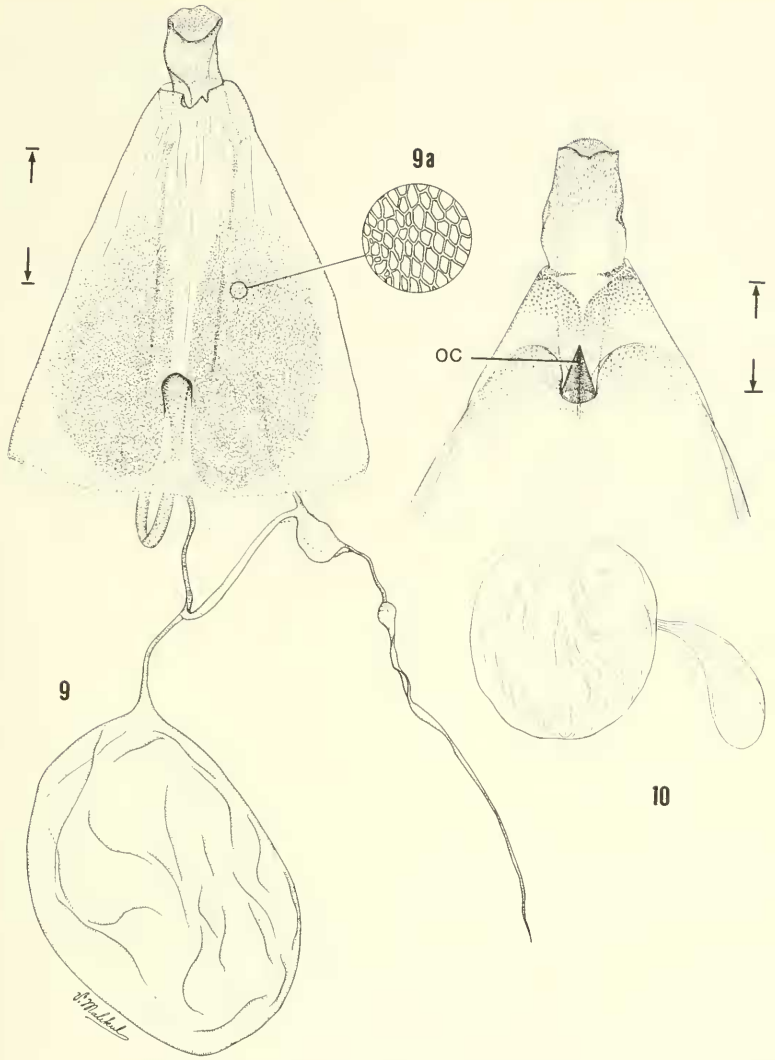
The fact that we collected only females of *A. selvae* or *Ptilopsaltis santarosae* (see below) is a striking departure from the other documented case of moths that are phoretic on mammals: "The continuous, phoretic association of female moths with sloths facilitates the location of fresh dung piles for oviposition. In *Cryptoses choloepi* Dyar in Panama, males are three to four times as common (on) sloths as females, although the primary sex ratio is about one to one (Waage and Montgomery, 1976). Perhaps this reflects the tendency of males to remain and accumulate on sloths in order to compete for newly-arriving females, in contrast to a regular loss of females from the host population at each defectation by the host." (Waage, 1979). Because oviposition and the early developmental stages of *A. selvae* presumably occur in the nest of *H. desmarestianus,* phoresis most likely serves as a temporary means of dispersal among nests for females in search of new oviposition sites. Knowledge of the primary sex ratio for *A. selvae* must await the collection of more material, probably via the excavation of burrows.

Ptilopsaltis santarosae Davis, New Species

Figs. 3, 6, 9, 13–16

Adult (Fig. 3).—Length of forewing: ♀, 8–9.5 mm. A moderately large moth with light buff forewings marked with numerous, scattered dark brownish fuscous spots of various sizes. Male unknown.

Head: Vestiture of vertex light to medium brown; frons mostly cream to white with a patch of medium brown scales arising near base of frons and inner rim of eye. Antennae approximately 0.8 the length of forewing, 79–86 segmented; scape smooth, without pecten, uniformly light buff; flagellum uniformly stramineus, nearly white at apex. Maxillary palpi extremely reduced, less than 0.5 the length of labial palpus I, 3-segmented, basal segment nearly sessile; vestiture light brown to buff. Labial palpi well developed 3-segmented; vestiture light brown, becoming



Figs. 9, 10. Female genitalia, ventral view. 9, *Ptilopsaltis santarosae*. 9a, Detail of surface of eighth sternite. 10, *P.* species, OC = ostial cone. (Scales = 0.5 mm.)

pale buff to nearly white on segment III; II with a prominent ventral brush and 2–3 dark bristle-like setae laterally; vestiture of III smooth.

Thorax: Pronotum mostly light brown with darker brown on anterior edge of tegulae. Venter predominantly white. Forewings light buff with dark, brownish fuscous spots scattered over dorsal surface; spots most noticeable along costa, with a relative large, oblique spot at apex of discal cell and another near base of forewings; fringes light buff. Hindwings uniformly pale silvery gray. Forelegs with coxa and femur pale buff; tibia and tarsal segments brownish fuscous dorsally, with apices light buff, whitish ventrally; pretarsi with one pulvillus greatly reduced;

pseudempodial seta reduced; arolium normal. Midlegs mostly light buff; tibia and tarsi only slightly darker dorsally; pretarsi with one pulvillus and pseudempodial seta reduced as in forelegs. Hindlegs mostly whitish; tibia and tarsi light buff dorsally; pretarsi with arolium and pseudempodial setae greatly reduced, pulvilli symmetrical, claws elongate and only slightly curved.

Abdomen: Light buff.

Female genitalia: As shown in Fig. 9. Ovipositor extremely short, slender. Anterior apophyses absent. Eighth sternite enlarged, approximately twice the length of 8T, with a large pair of ovoid, lightly sclerotized plates bearing a finely reticulate surface (Fig. 9a); ostial cone greatly reduced, apex rounded, barely rising from 8S, opening of ostium situated at anterior third of 8S. Ductus bursae slender but larger than any other species of *Ptilopsaltis,* becoming more slender toward juncture with corpus bursae; corpus bursae nearly round; signum absent.

Immature stages.—Unknown.

Holotype.—♀. Santa Rosa National Park, 25 km S of La Cruz, Guanacaste Province, Costa Rica; 22 May 1983, coll. D. H. Janzen, USNM type no. 100673 (USNM).

Paratypes.—Costa Rica: Same locality as holotype: 3 ♀, 12 May 1984; 1 ♀, 14 May 1984; 2 ♀, 22 May 1983; 1 ♀, 5 Aug. 1984. Paratypes deposited in BMNH, MNCR and USNM.

Host.—Larval substrate unknown; adult females collected from fur of live *Liomys salvini.*

Flight period.—May, August.

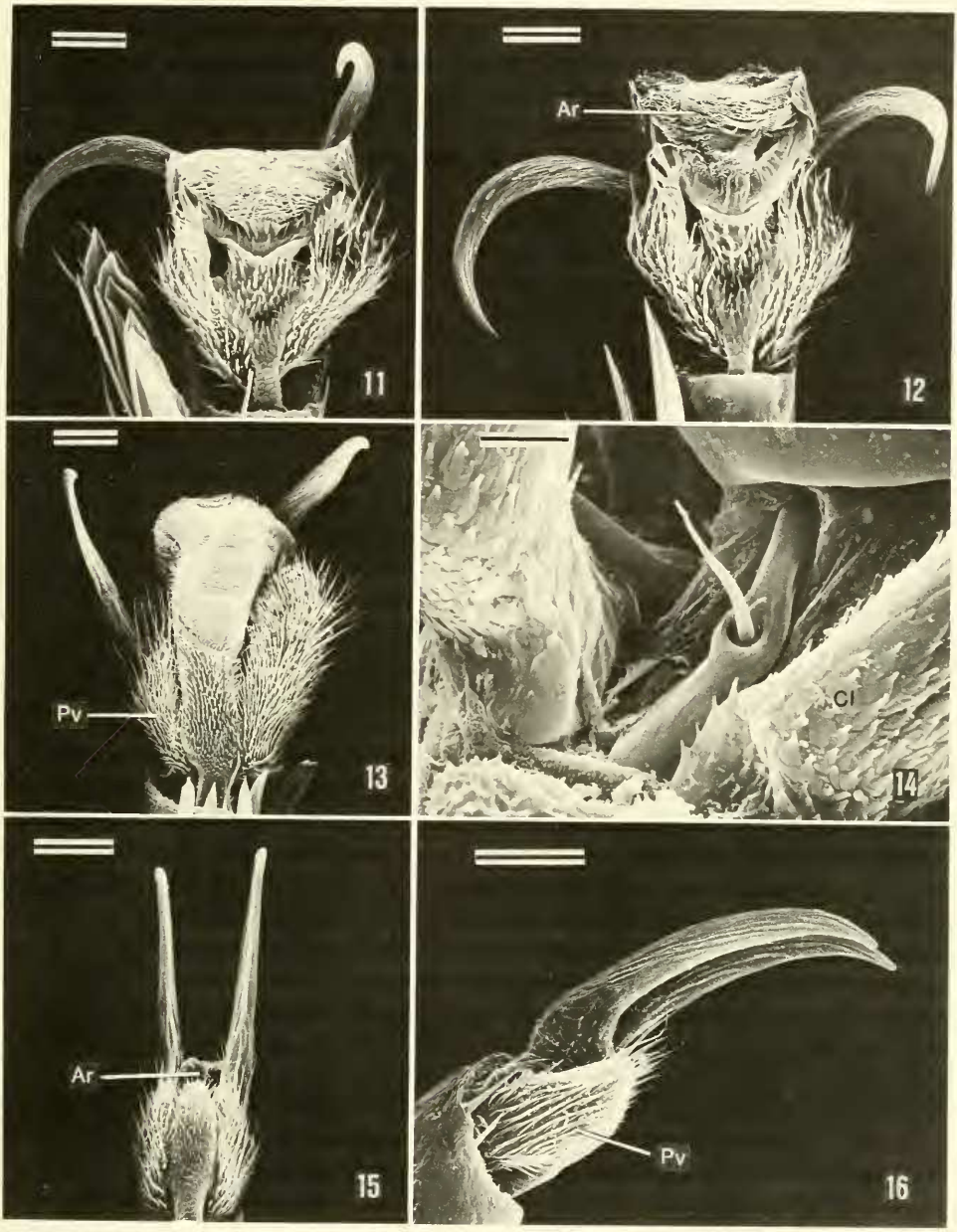
Distribution.—Known only from the type locality, which is a lowland deciduous forest site (ca. 250–300 m) in Santa Rosa National Park, 25 km south of La Cruz in the northwest corner of Guanacaste Province, Costa Rica.

Etymology.—The species name is derived from the type locality (Santa Rosa).

Discussion.—Of the several species of *Ptilopsaltis* known (but mostly unnamed), the female of this species is unique in having the ostial cone greatly reduced and rounded. In all other species, this structure is decidedly conical in form and often strongly attenuated. Another apomorphy of *P. santarosae* is the presence of a pair of nearly contiguous, finely reticulated, ovoid areas on the eighth sternite (Fig. 9a).

A second species of *Ptilopsaltis* has been collected on *Heteromys desmarestianus* at La Selva. Although superficially similar in appearance (as are most members of this genus) the two species are easily differentiated by their characteristic female genitalia (Figs. 9, 10). Description of the La Selva species will have to await the collection of more suitable type material.

Biological observations.—All specimens of *Ptilopsaltis santarosae* were collected while they were riding on the dorsum of *Liomys salvini* (Thomas) in Santa Rosa National Park, 25 km south of La Cruz, northwestern Guanacaste Province, Costa Rica. *L. salvini* is a 20–70 g heteromyid mouse that is active as a seed collector on forest litter at night (Janzen, 1982). While the actual collection dates were 22 May 1982, 12–14 May 1984, and 5 August 1984, other moths were observed on the mice in all other months of the year (1981–1984). The mice were trapped in *Enterolobium* seed-baited Sherman live traps during the night, and



Figs. 11–16. Pretarsal morphology. 11, *Amydria selvae,* midleg, ventral view (scale = 20 μm). 12, Hindleg (Ar = arolium; scale = 20 μm). 13, *Ptilopsaltis santarosae,* midleg (Pv = pulvillus; scale = 40 μm). 14, Pseudempodial seta between bases of claws, dorsal view (Cl = claw; scale = 10 μm). 15, Hindleg, ventral view (Ar = arolium; scale = 40 μm). 16, Hindleg, lateral view (Pv = pulvillus; scale = 40 μm).

removed between 0700 and 1100 hours. If the mouse was not roughly handled, the moth remained motionless while clinging tightly to the surface of fur just above the base of the tail (dorsally) or in the center of the back just behind the head (Fig. 6). If the mouse was dumped into a plastic bag and jumped about frantically, the moth often flew off. However, if the moth and mouse were then left together in the bag, the moth quickly again assumed a stationary position on the mouse. If the moth was freed from the plastic bag, it flew a few tens of centimeters and then perched motionless on a solid substrate.

Moths were taken off of *L. salvini* of both sexes, ranging from 18 g youngsters (probably foraging from their mother's nest) to 50–70 g fully reproductive adults. In nine cases, there was a single moth per mouse, and in one case there were two moths, riding side by side. All eleven moths collected were females. Presumably these moths were dispersing among nests by riding on the mice. This suggests that the mice occasionally enter each other's burrow systems or even nests. However, the information gathered to date suggests that *L. salvini* normally exist at a density of one adult per nest or even burrow system (see Fleming, 1983).

At Santa Rosa, the moths were collected from mice in pristine, nearly evergreen forest (Bosque Humedo Mouse Plot) and in 60 to 90-year-old secondary successional vegetation (San Emilio Mouse Plot). Small moths, presumably *P. santarosae,* were noticed riding on *L. salvini* taken in live traps in late successional secondary deciduous forest in Finca La Pacifica, 7 km north of Canas, Guanacaste province, Costa Rica (T. H. Fleming, personal communication).

Acknowledgments

The senior author (Davis) is responsible for the systematic portions of this paper, with the biological observations involving *Heteromys desmarestianum* compiled by D. H. Clayton and A. P. Brooke and those of *Liomys salvini* by D. H. Janzen. We are indebted to Vichai Malikul for the line drawings and to Victor Krantz of the Smithsonian Photographic Laboratory and Susann Braden of the Smithsonian SEM Lab for photographic assistance. The photographs of *Heteromys* and *Liomys* were by Michael Fogden and W. Hallwachs respectively. The final draft of the manuscript was prepared by Silver West. We also wish to acknowledge W. Haber, J. Powell, and R. Timm for the loan of material and other assistance. Financial support was provided by the Organization for Tropical Studies (to DHC) and NSF BSR 83-08388 (to DHJ).

Literature Cited

Bell, J. F. and C. Clifford. 1964. Effects of limb disability on lousiness in mice. II. Intersex grooming relationships. Experimental Parasitology. 15: 340–349.

Davis, D. R. 1972. *Tetrapalpus trinidadensis,* a new genus and species of cave moth from Trinidad (Lepidoptera: Tineidae). Proceedings of the Entomological Society of Washington. 74: 49–59.

———. 1984. Tineidae. Pp. 19–24. *In* J. R. Heppner (editor), Atlas of Neotropical Lepidoptera, Vol. 2, Checklist, pt. 1 (Micropterigoidea to Immoidea). W. Junk, The Hague.

Fleming, T. H. 1974. The population ecology of two species of Costa Rican heteromyid rodents. Ecology. 55: 493–510.

———. 1983. *Liomys salvini.* Pp. 475–477. *In* Costa Rican Natural History, D. H. Janzen, ed., University of Chicago Press, Chicago.

Janzen, D. H. 1982. Removal of seeds from horse dung by tropical rodents: influence of habitat and amount of dung. Ecology. 63: 1887–1900.

Jellison, W. L. 1940. Biologic studies on the faunae of nests of birds and rodents. Unpub. Ph.D. dissertation. University of Minnesota Archives.

Johnson, N. E. and P. Martin. 1969. *Amydria effrentella* from nests of mountain beaver, *Aplodontia rufa*. Annals of the Entomological Society of America. 62: 396–399.

Marshall, A. G. 1981. The ecology of ectoparasitic insects. Academic Press. London. 459 pp.

Waage, J. K. 1979. The evolution of insect/vertebrate associations. Biological Journal of the Linnaean Society. 12: 187–224.

Waage, J. K. and G. G. Montgomery. 1976. *Cryptoses choloepi*: a coprophagus moth that lives on a sloth. Science. 193: 157–158.

Walsingham, Lord (Thomas de Grey). 1909–1915. *In* Godman and Salvin, Biologia Centrali-Americana, 42 (Lepidoptera-Heterocera, 4); i–xii, 1–24 (1909); 25–40 (1910); 41:112 (1911); 113–168 (1912); 169–224 (1913); 225–392 (1914); 393–482 (1915); pls. 1–10.